Graduate Thesis Project:

Combining multimodal Signal Information (EEG/EMG) for reliable lower-limp motion intention decoding

Several convergent evidences have revealed a link between EEG signals and locomotion. For instance, during initiation and execution of movement, decrease in the power of beta frequencies has been observed. This decrease in the power however is restricted to the electrodes overlying the cortical areas corresponding to the moving limb. Obviously, this power spectral based univariate technique inherits significant drawback of the limited number of the EEG sensors. Besides, the receptive fields of the lower limb in the primary sensory cortex are located in the bank along the inter-hemispheric fissure and the crown of the post-central gyrus, making the lower limb related motor intention detection a challenge.

The robustness and accuracy of lower limp motion intention decoding can be improved and the processing speed can be increased by using coherence measures of EEG and EMG and synchronization techniques and dimensionality reductions methods respectively. Moreover, fusion of information extracted from EEG and EMG signals is well suited for increasing the accuracy of features extraction and classification. It can be used to improve the control reliability of robotic exoskeleton and wearable sensory systems used for rehabilitation. The combined real-time EEG/EMG signal analysis has the potential to improve exoskeleton robots performance and remove limitations for application in real life.

The main goal of this graduate thesis project will be to develop optimal ways to combine multimodal signal information (EEG/EMG) for reliable lower limp intention decoding. The methods to be introduced will be tested and evaluated with real data. The results are expected to be published in high quality conferences/journals. The project could evolve to a doctoral level thesis.

Required Background/qualifications: Digital Signal Processing, Pattern Recognition, Machine Learning, excellent Matlab programming skills, excellent English (oral and written communication skills). Interest in high quality research, ability to work in an interdisciplinary team environment.

Desirable qualifications: Experience with EEG signal processing and BCIs. Knowledge/experience in Neuroengineering. Contribution to publications, previous research project experience.

Expected duration: 6-8 months.

Availability: Immediate (Spring 2015). The selected student is expected to spend 2-3 months in Singapore at the start of the project (expenses will be covered).

References:

1. Gwin JT, Ferris DP. An EEG-based study of discrete isometric and isotonic human lower limb muscle contractions. *J Neuroeng. Rehabil.* 2012; 9:35
2. R. Bortel, P. Sovka, EEG-EMG coherence enhancement, *Signal Processing*, vol. 86 (7): 1737-1751, 2006.
3. Petersen TH, Willerslev-Olsen M, Conway BA, Nielsen JB. The motor cortex drives the muscles during walking in human subjects. *J. Physiol.* 2012 May 1;590(Pt 10):2443-52.

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